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III. *Observations concerning the Height of the Barometer, at different Elevations above the Surface of the Earth, in a Letter to the Publisher from the Learned Dr. Nettleton.*

S I R,

**B**EING curious to learn by Observation, how far the Mercury will descend in the Tube at any given Elevation, for which there is sufficient Opportunity hereabouts, I propos'd to take the Altitude of some of our highest Hills; but, when we attempted it, we found our Observations so disturbed by Refractions, that we cou'd come to no Certainty. Having measur'd one Hill of a considerable Height, in a clear Day, and observed the Mercury at the Bottom and at the Top, we found, according to that Estimation, that about 90 Feet, or upwards, were required to make the Mercury fall one Tenth of an Inch; but coming afterwards to repeat the Experiment on a cloudy Day, when the Air was somewhat gross and hazy, we found the small Angles so much augmented by Refraction, as to make the Hill much higher than before, tho' they were taken carefully with very good Instruments, both at that Time and before. I afterwards frequently observ'd at home, by pointing the Quadrant to the Tops of some of our neighbouring Mountains, that they wou'd appear higher in the Morning before Sun-rise, and also late in the Evening, than at Noon, in a clear Day, by several Minutes: Particularly, one Morning in *December* last, when the Vapours lay condens'd in the Vallies, and the Air above was very pure, the Top of a Mountain, at some Distance  
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from hence, appear'd more elevated, by above 30 Minutes, than it had done in the Beginning of *September* about Noon, on a very clear Day. From whence it appears, that the Refraction is at some times greater than at others ; but probably 'tis always very considerable, and, as there is no certain Rule to make Allowance for it, it seems likely, that all Observations made on very high Hills, especially when view'd at a Distance, and under small Angles, as they commonly are, are uncertain, and scarce to be depended on, generally erring in making the Heights greater than they really are.

I then proceeded to observe, as near as I was able, the Refraction of the Mercury in some smaller perpendicular Directions, which we cou'd measure with a Line, and also on the Tops of some Hills of a moderate Height, whose Altitude we cou'd observe most commodiously, and, by taking the Angles large, avoid the Danger of any considerable Refraction.

At the Bottom of the Tower of *Halifax* Church, the Mercury stood at 29 *Inch.* 78 *Dec.* At the Top it subsided to 29. 66. The Height of the Place, where the Observation was made, was found to be 102 Feet.

At the Bottom of a Coal-Mine, near this Place, the Mercury stood at 29. 48. At the Top, it fell to 29. 32. The Depth of the Mine, being measured, was found to be 140 Feet.

At the Bottom of another Mine, the Mercury was observed to stand at 29. 50. At the Top, it fell to 29. 23. The Depth of this Mine was 236 Feet.

At the Foot of a small Hill, whose Height we cou'd measure very exactly, the Mercury stood at 29. 81. At the Top it fell to 29. 45. The Height of the Hill was 312 Feet.

At the Bottom of *Halifax* Hill, commonly call'd the Bank, the Mercury was observed to stand at 30. 00.

At the Top, it fell to 29. 41. The Height of this Hill was found to be 507 Feet.

Our Mathematicians do demonstrate, that the Density of the Air decreases in a Geometrical Progreſſion, as the Elevation encreaſes in an Arithmetical one, and confequently, that the Logarithms of the Densities are as the Elevations reciprocally. But the Weight of the Air being as its Density, and the Height of the Mercury in the Barometer being always proportional to the Air's Weight, it follows, that the Logarithms of the Heights of the Mercury are, reciprocally, as the Elevations: Whence having found by Observation, what Elevation is requir'd to make the Mercury ſtand at any Height, it will be eaſy to determine, how much is requiſite to reduce it to any other Height propos'd. If we make 30 Inches the Standard Height of the Mercury, equal to Unity, and ſuppoſe an Elevation of 85 Feet be requir'd to make it fall one Tenth of an Inch from that Height, as by theſe Observations it is very nearly; then as the Logarithm of  $\frac{30,0}{29,9}$  is to 85, ſo is the Log.

$\frac{30,0}{29,5}$  to the Number of Feet requir'd to make it fall Half an Inch, and ſo of the reſt. When the Mercury ſtands above 30 Inches, the Numbers will be negative, and ſhew the Spaces deſcending; by which Method I computed the following Tables.

The latter, which contains the Differences of the Numbers in the former, was of very great Uſe to me, when, in theſe Experiments, the Mercury ſtood at any other Height in the Tube, beſides 30 Inches, and fell any Number of Tenths, or Parts of a Tenth, by adding the Numbers anſwering thereto, or proportionable Parts of them, to find the Elevation requir'd in the Table, to make the Mercury fall ſo much, and thereby readily  
to

to compare the Heights found by Observation therewith. And though some small Errors, in the Observations, do make them vary a little from each other, yet in the main, they agree as near as possible with the Numbers of the Table ; as did also several other Experiments too long to mention, which makes me believe those Numbers are not far from the Truth ; but of that you will be best able to judge, by comparing these Experiments with others of the same Kind.

That the Air is colder, as well as more light and rare, in Places that are situated high, than it is in the Vallies and low Grounds, is generally known; and in order to learn, how much it might be so, I got a Friend of mine, who lives higher than we do here, to observe the portable Barometer and Thermometer, at his House, for some Days, being plac'd as near as possible in the same Circumstances with mine ; and we found his Barometer stood at a Medium for 20 Days, 3 Tenths lower than mine, and the Thermometer 3. *deg.* 2. lower ; allowing for the Difference of the Instruments, which had been observed before.

At another Place the Barometer, at a Medium for 14 Days, stood lower by 4. 46. and the Thermometer was lower by 4. *deg.* 4. At another Place, which was very high upon the Moors, the Barometer, at a Medium for ten Days, stood lower by 0. 65. and the Thermometer fell 7°.

A Table shewing the Number of Feet ascending, requir'd to make the Mercury fall to any given Height in the Tube, from 30 to 26 Inches. As also the Number of Feet descending, requir'd to make the Mercury rise, from 30 to 31 Inches.

In. Dec.	Feet Dec.	In. Dec.	Feet Dec.
31	0834	29	27
30	9752	28	81938
30	8670	27	72030
30	7587	26	62122
30	6504	25	52215
30	5420	24	42307
30	4337	23	32401
30	3253	22	22494
30	2169	21	12588
30	184	20	02682
30	000	19	92776
29	985	18	82871
29	8170	17	72966
29	7255	16	63062
29	6341	15	53158
29	5427	14	43254
29	4514	13	33351
29	3601	12	23448
29	2688	11	13545
29	1775	10	03643
29	0863	09	
28	9951	08	
28	81039	07	
28	71127	06	
28	61216	05	
28	51305	04	
28	41395	03	
28	31485	02	
28	21575	01	
28	11665	00	
28	01756		

A Table shewing the Number of Feet requir'd to make the Mercury fall one Tenth of an Inch from any given Height in the Tube, from 31 to 26 Inches.

In. Dec.	Feet Dec.	In. Dec.	Feet Dec.
31	082	27	991
30	982	26	891
30	882	25	792
30	783	24	692
30	683	23	592
30	583	22	493
30	483	21	393
30	384	20	293
30	284	19	194
30	184	18	094
30	085	17	994
29	985	16	895
29	885	15	795
29	785	14	695
29	686	13	596
29	586	12	496
29	486	11	396
29	387	10	297
29	287	09	197
29	187	08	098
29	087	07	
28	988	06	
28	888	05	
28	788	04	
28	689	03	
28	589	02	
28	489	01	
28	390	00	
28	290		
28	190		
28	091		